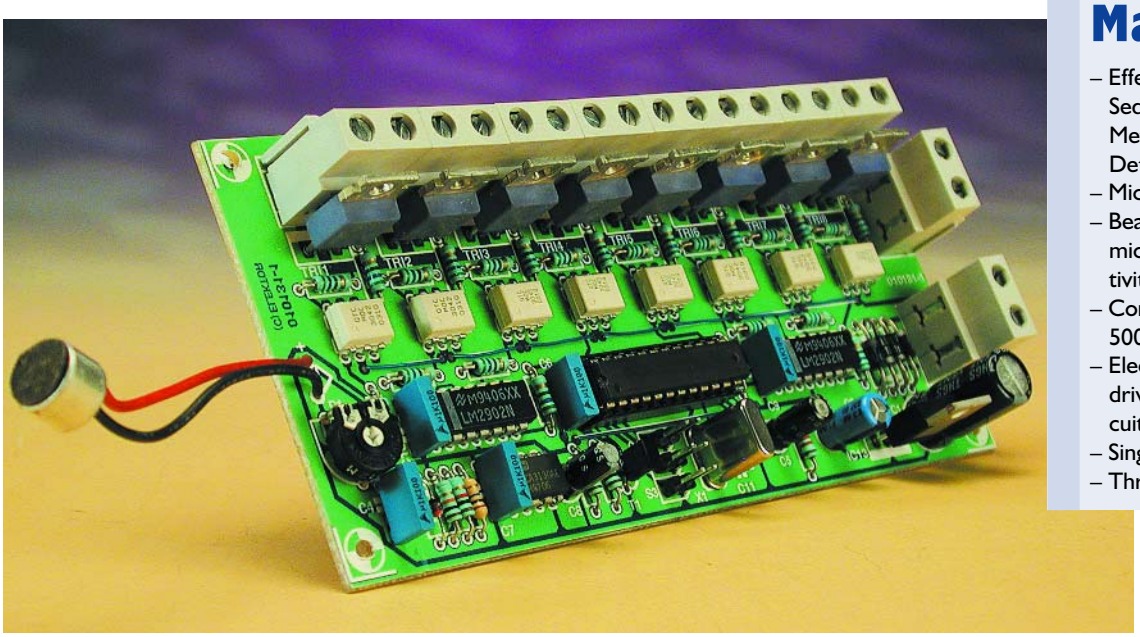
8-Channel Disco Light Controller

up to 500 watts per channel

Design by Tom Varley

The unit is designed as a stand alone disco lighting controller but can be used for driving eight sets of Christmas tree lights, shop display lights etc. It is sound activated and self-running. The effects are blackout, flood, VU meter, streak and pattern sequence. The only controls needed are three pushbuttons. It's based around the popular 87C750 OTP device from Philips and was designed with a DJ or small band with a need to drive eight 500-watt PAR-56 lighting cans with a minimum of fuss.



Main features

- Effects: Flood, Blackout, Pattern Sequence, Beat Detect, VU Meter, Fast Chase on Beat Detect
- Microprocessor controlled
- Beat detector with built-in microphone and adjustable sensitivity
- Controls 8 stage lights of up to 500 watts each
- Electrical isolation between lamp drivers and microcontroller circuit
- Single-board construction
- Three-button control

This project should satisfy, at least for a while, those of you who have written to us clamouring for disco light effects units. Apparently commercial units with serious specifications are not only few and far between but also relatively expensive, hence our hopefully successful go at publishing a DIY unit. Don't be put off by 'hopefully', it's false modesty. As with all projects supported by printed circuit boards and software supplied through our Readers Services, the present project has been thoroughly tested by our in-house design staff, in close co-operation with the author,

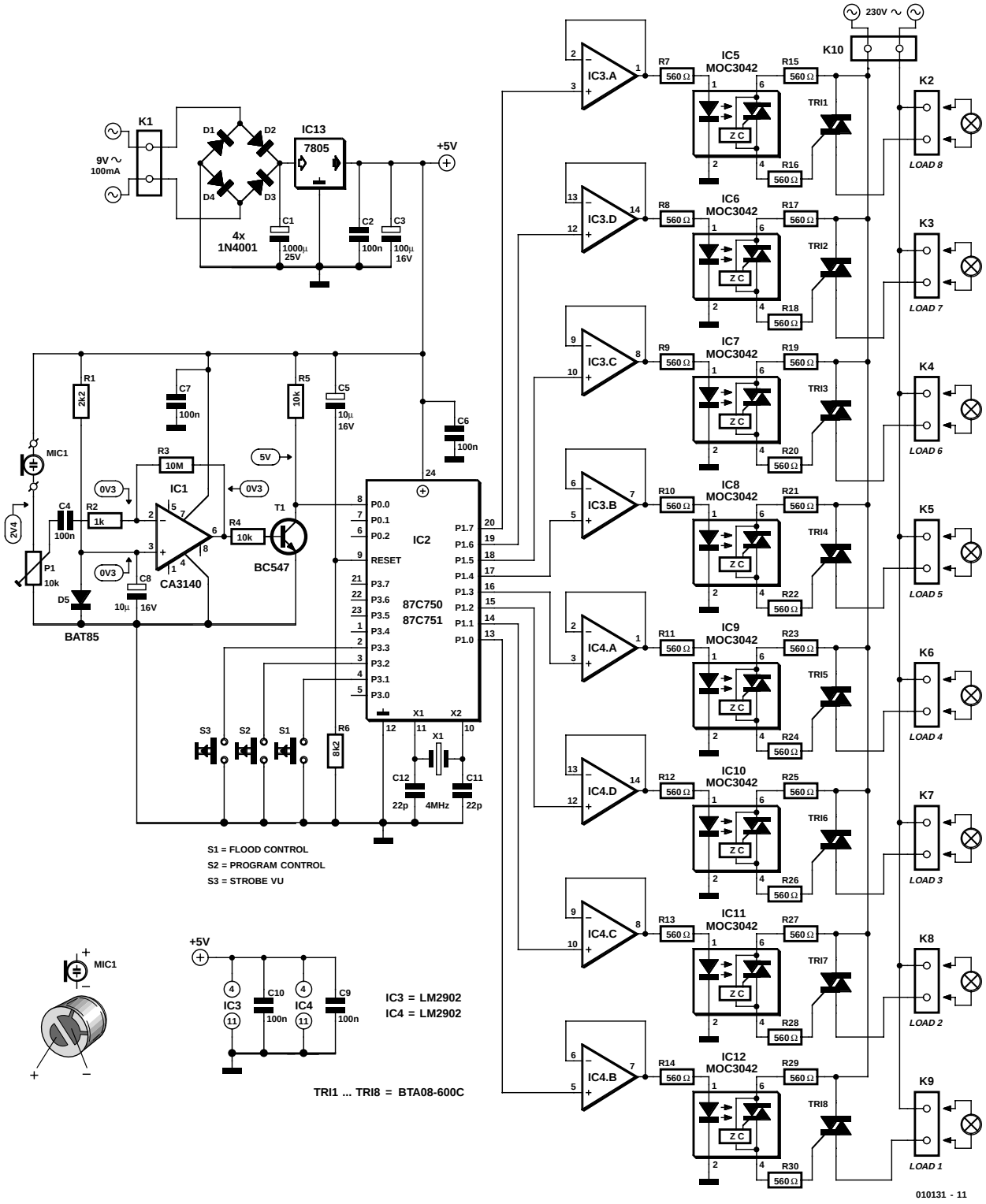


Figure 1. Circuit diagram of the 8-channel disco lights controller.

Tom Varley, who has live-tested the circuit with a performing band.

Circuit description

The schematic shown in **Figure 1** combines the digital and analogue sections in a single diagram. This is intentional because in reality these sub-circuits are contained on a single, single-sided printed circuit board.

The heart of the design is a microcontroller type 87C750 or 87C751, which has been programmed to look at the state of control switches S1, S2 and S3, as well as the output of comparator IC1.

Since the circuit is required to respond to acoustic stimuli (pounding bass speakers, etc.) a preamplifier is required to tell the microcontroller whenever such a signal is present. For this purpose a standard miniature electret microphone capsule with a DC

impedance of 2 kΩ is used. The microphone sensitivity is adjusted using preset P1 whose DC path also provides the capsule bias voltage. The gain of the preamp can be a few thousand times because neither distortion nor high-frequency response are an issue here. Because the opamp will only amplify alternating signals, its dc gain is unity (1?). Consequently the opamp inputs, and the output, are at a dc level equal to the forward drop of Schottky diode D5, or about 0.3 V. Using a 'normal' silicon diode in this position would produce a level of about 0.6 V which is enough to make T1 conduct all the time, and that is undesirable. When no sound is detected, the collector of T1 should be at about +5 V. Summarizing, an acoustic signal of sufficient level picked up by the microphone is turned into a square wave with a logic swing that can be detected and processed by the microcontroller, using its port line P0.0.

Almost any type of pushbutton switch can be used as there is a comprehensive debounce algorithm as part of the software running inside the micro.

Ports lines P1.0 through P1.7 of the micro drive opamp buffers type LM2902 (IC3-IC4). Each of the buffered opamp outputs in turn drives an LED inside an opto triac driver (IC5-IC12). The micro needs buffering to reduce load constraints on the port lines. The opto-triac drivers are a simple method of providing zero crossing (ZC) to reduce switching noise while providing a few kV of electrical isolation between the 'hot' lamp circuits and the delicate electronics. The triacs Tri1-Tri8 may be wired via PCB terminal blocks to two Bulgin sockets or eight individual mains sockets for connection of the lights or light units. More about this further on.

The author experimented with different values for biasing the triac driver. In practice, 560 Ω works fine and being the same value as the LED bias resistor reduces the number of resistor values. The MOC3042 may be replaced by its slightly more sensitive sibling the MOC3043. The MOC3041 is not suitable here. The triacs, too, are uncritical, and virtually anything may be used that's capable of switching 400 V at about 4 A.

The standard power supply arrangement of a ready-made mains adapter (9 VAC or 9 VDC, 300 mA) or a dedicated transformer, a bridge rectifier (D1-D4) and a fixed voltage regulator (IC13) is a good low-pass filter for mains-borne noise and transients. The supply should always include the 0.1 μF decoupling capacitor. Thanks to the bridge rectifier, the supply works irrespective of the output polarity of the mains adapter.

The microcontroller is running at 4 MHz using a quartz crystal, X1, and the usual pair of small ceramic capacitors, C11-C12. C5 and R6 are the boot-up components that hold the RESET pin high for a minimum of two machine cycles when power is applied to the board. This is the recommended cold start for 8051 architecture devices.

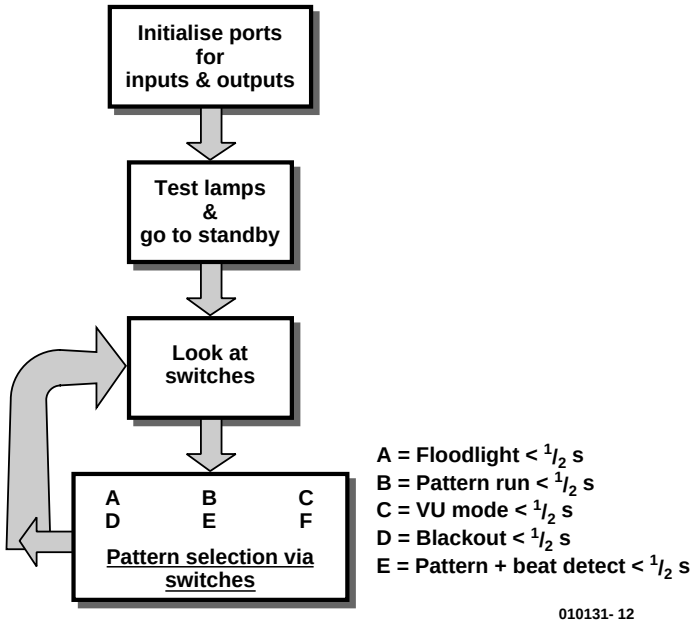


Figure 2. Flowchart of the pushbutton reading routine.

Software and operation

The program inside the 87C750 (or '751) black box was written as assembler and is about 150 lines of code, the rest of the program memory area (1 K for the 87C750) is used as a lookup table which simply determines which lamps are turned on. After the board is powered up the micro is initialised so that port 1 is briefly strobed, driving all the lights on in sequence, to give visual indication of power up. After the strobe is run, the device puts itself into a loop and starts to look at the switches. Each switch has two functions. The first function is achieved

COMPONENTS LIST

Resistors:
R1 = 2kΩ2
R2 = 1kΩ
R3 = 10MΩ
R4,R5 = 10kΩ
R6 = 8kΩ2
R7-R30 = 560Ω
P1 = 10kΩ preset

Capacitors:
C1 = 1000μF 25V radial
C2,C4,C10 = 100nF
C6,C7,C9 = 100nF, 7.5mm lead pitch
C3 = 100μF 16V radial
C5, C8 = 10μF 16V radial
C11,C12 = 22pF ceramic

Semiconductors:
D1-D4 = 1N4001
D5 = BAT43 or BAT85 (Schottky)
IC1 = CA3140, CA3130
IC2 = 87C750 or 87C751, programmed, order code **010131-41**
IC3,IC4 = LM2902
IC5-IC12 = MOC3042
IC13 = 7805
T1 = BC547

Miscellaneous:
K1-K10 = 2-way PCB terminal block, lead pitch 7.5mm
MIC1 = electret capsule
S1,S2,S3 = pushbutton, 1 make contact
TRI1-TRI8 = BTA08-600C (BCR6 AM 8)
X1 = 4MHz quartz crystal
PCB, order code **010131-1**

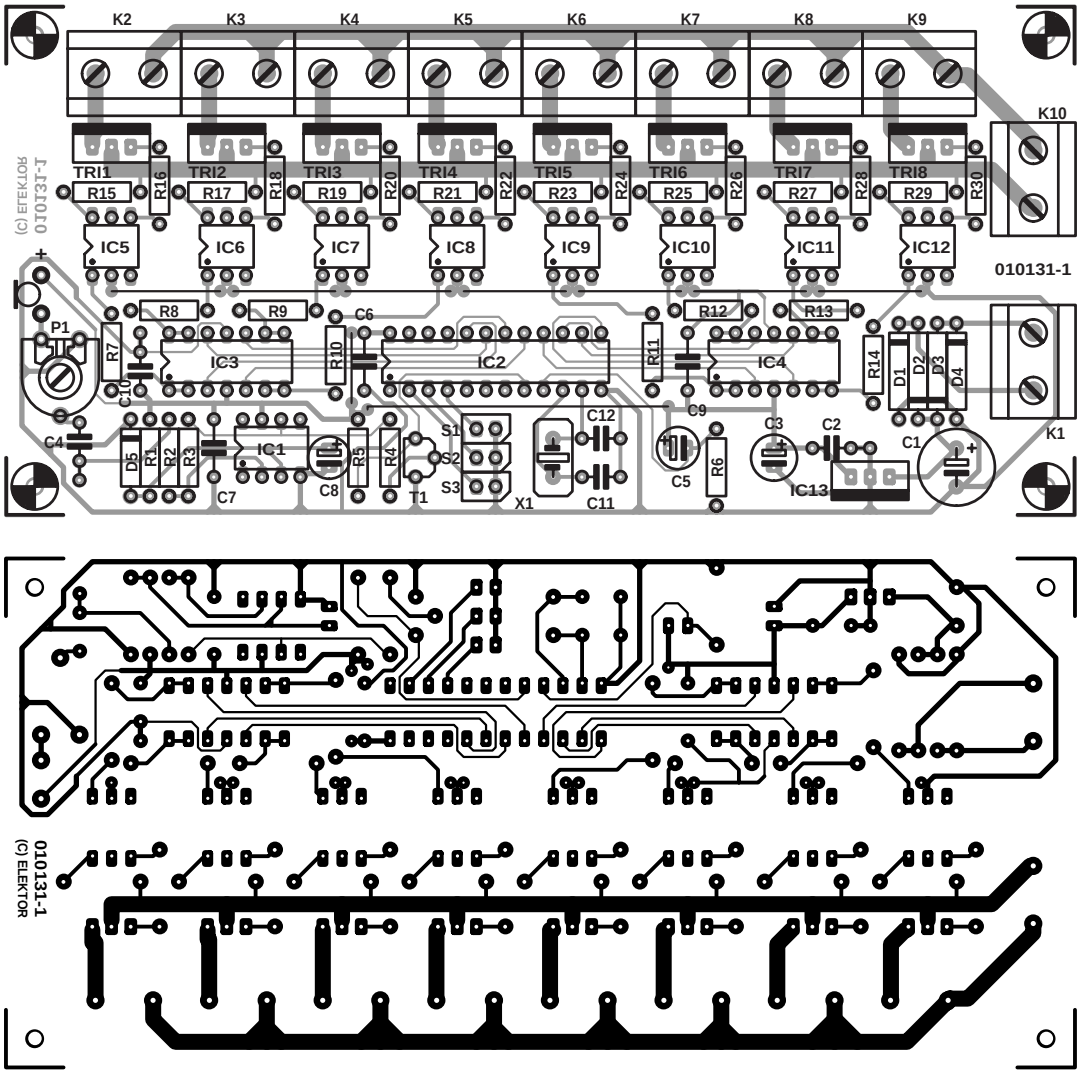


Figure 3. Copper track layout and component overlay of the single-sided PCB designed for the unit (board available ready-made).

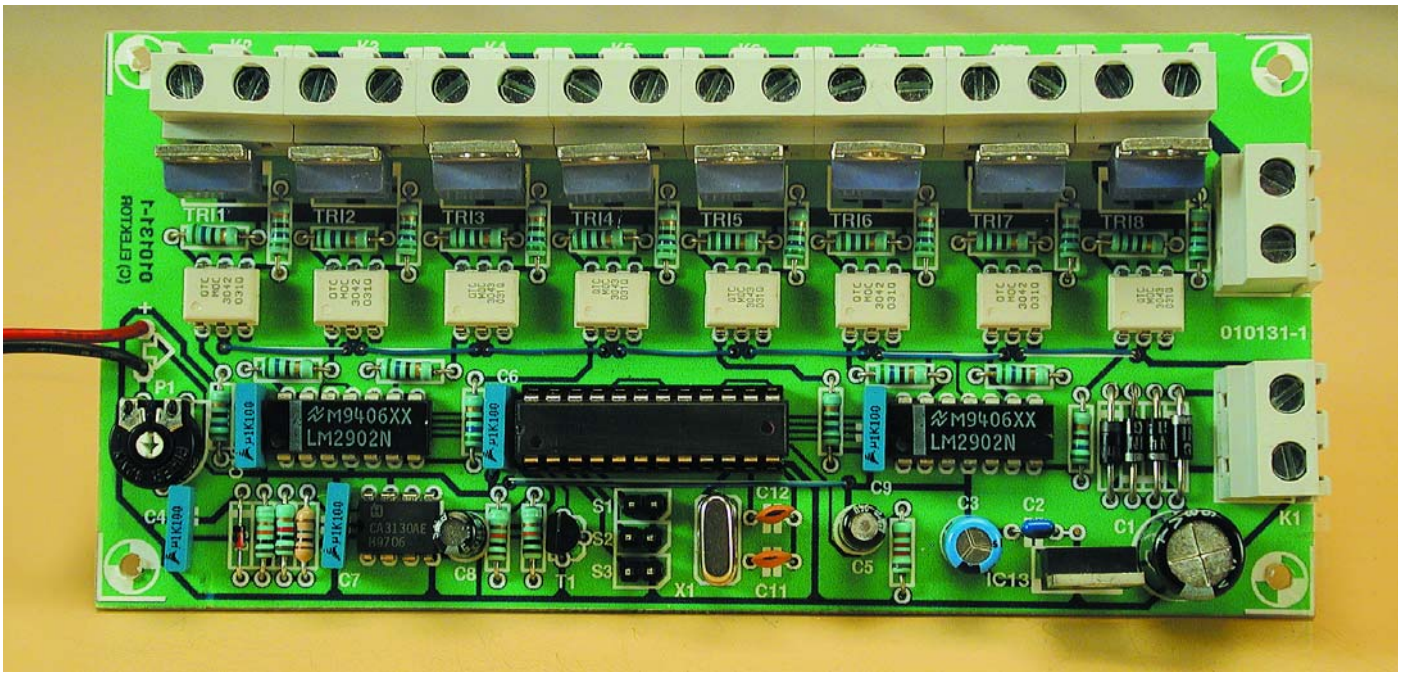


Figure 4. This is what our finished an tested board looks like. Note that the three pushbuttons (not shown) are connected via pin strips.

by depressing the switch for less than half a second, these functions are A, B & C. The second layer of functions are reached by depressing the relevant switch for more than half a second. It should be noted that if you keep the switch depressed it will loop around the top and bottom functions of the switch. The chart in **Figure 2** indicates which function can be selected. Once selected, the controller will operate in this mode until a new function is selected.

Because the author receives royalty payments for every ready-programmed microcontroller sold, the assembly code listing of the program burned into IC2 will not be made available as usual through our website, or on a floppy disk. Ready-programmed ICs for this project are however available from Readers Services, the order code is **010131-41**.

Assembly

The electronics fits neatly on a **single-sided** PCB, the layout of which is shown in **Figure 3**. No problems or difficulties are envisaged if you work carefully, take your time and stick to the parts list and the component overlay printed on the board. For your convenience, our tested prototype is shown in **Figure 4**. There are **nine wire links** on the board, we suggest counting them to make sure you haven't missed one.

The electret capsule is connected to the PCB via a short two-wire cable. Depending on how well sealed the case is and how flexible the case walls are will determine the bass sensitivity of the microphone. If air can pass through the case with ease then the microphone will be sensitive to bass. Experimentation with the mechanical coupling of the microphone to the PCB or case wall will also change the acoustic response characteristics. The choice of the electret capsule is not critical, and even the cheapest ones will work fine. Usually, the capsule has two solder pads at its rear side. The pad connected to the metal encapsulation is the negative (–) connection (see also the insert in the circuit diagram).

The triac output connectors K1-K8 may be wired to 8 separate mains sockets allowing each stage light (or cluster of lights) to be powered via its own cable.

Some of you may want to employ two 'Bulgin' 8-way sockets, one for each group of four lamps. The easiest way of wiring to the IEC socket and the Bulgin connectors is to prewire tails from the PCB pins and thread these tails through the relevant holes in your case. Once the PCB is secured inside the case you can then solder the sockets. If you are using a steel case make sure that all parts of the case are earthed to the IEC socket earth pin.

If used, the Bulgin connectors should be wired as follows:

Pin 1	Protective Earth
Pin 2	Light 4 (or 8)
Pin 3	Light 3 (or 7)
Pin 4	Light 2 (or 6)
Pin 5	Light 1 (or 5)
Pin 6	n.c.
Pin 7	Neutral
Pin 8	Neutral

Whatever the method used to connect the stage lights to the circuit, **great care must be taken and proper materials used to eliminate any risk of the mains voltage being touched**. In this respect, we advise (re-)reading our notes on Electrical Safety which are published every few months in this magazine.

Testing

Warning

The mains voltage must be removed from K10 before doing any measurements or testing on the circuit. When the mains voltage is present on K10, the tabs of the triacs are LIVE. No matter if you decide to house the circuit in a solid plastic (ABS) or a steel enclosure, a proper connection to the mains Protective Earth (PE) terminal must be provided. The isolation distance on the circuit board is smaller than 6 mm so this equipment meets Class 1 only.

With no lights connected and the microcontroller out of its socket, power up via the mains adapter. Check for 5 volts at the regulator output, if it's not there check the diodes D1-D4 are the right way round and are being fed with the proper AC or DC voltage.

Once you have 5 volts, you can set up the microphone sensitivity. The room needs to be free of excessive background noise. Using a small screwdriver, rotate P1 fully counter-clockwise. Connect a scope probe or the DVM meter leads to IC1 pin 6. Slowly rotate the wiper and stop when pin 6 goes Low. Rotate the wiper counter-clockwise again and stop when the output swings High. Now clap your hands or whistle and the output should briefly change state when the microphone picks up the sound. Carefully tweak the setting of P1 until the toggling takes place reliably and at the desired acoustic level. Do remember that ambient noise levels will be very high in a discotheque!

Power down and install the microcontroller. Make sure the PCB is securely installed in the case and that the stage lights are connected to PCB terminal blocks K1-K8. If you do not have a set of lights handy you can either wire up 8 sets of fairy lights or hardwire 8 batten holders. Close the case and connect the mains power to K10.

Plug in the mains adapter and test the switch functions. Switch 1 if depressed will continually cycle with the light pattern (binary) as follows :

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